

AEC-Q103 qualified high performance analog XENSIV™ MEMS microphone

Features

- Automotive qualification
- Flat frequency response down to 10Hz for best ANC performance
- Close sensitivity and phase matching for optimum beam forming
- Environmental robust up to IP57
- Extended availability to match automotive design cycles
- Analog single-ended output

Potential applications

- Active noise cancellation / Road noise cancellation (ANC/RNC)
- Hands free calling
- Emergency call
- Voice control
- Siren detection
- Road condition detection

Product validation

Qualified for automotive applications by product validation according to AEC-Q103-003.

Description

The device is designed for applications where low self-noise (high SNR), wide dynamic range, low distortions and a high acoustic overload point is required. The low cut-off frequency (LFRO) makes it a well suited device for active noise cancelling (ANC) applications.

Infineon's MEMS technology is based on a miniaturized microphone design and results in high linearity of the output signal within a high dynamic range. With its low equivalent noise floor the microphone is no longer the limiting factor in the audio signal chain and enables higher performance of voice recognition algorithms.

The analog microphone ASIC contains an extremely low-noise preamplifier.

The tight manufacturing tolerance, combined with the fact that each device is calibrated with an advanced Infineon calibration algorithm, results in small sensitivity and phase matching tolerances. This makes it well suited for beam forming arrays and multi-microphone applications.

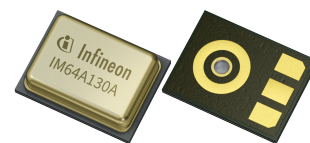


Table 1 Product summary

Parameter	Value	Customer benefit
SNR	64 dB(A)	Clear speech quality
THD 1%	116 dBSPL	Clear speech up to high SPL levels
AOP (THD 10%)	130 dBSPL	High dynamic range and high wind-noise robustness
LFRO	10 Hz	Flat frequency response for best ANC performance
T _A	-40°C ... +105°C	Flexible placement inside the car

Table 2 Order information

Product name	Package	Marking	Ordering code
IM64A130A	PG-TLGA-4-2	IA64A1	SP006020276

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1 Block diagram

The device contains two different dies combined inside one package.

The MEMS picks up the sound waves and converts them into an electrical signal. The ASIC contains all needed circuitry for biasing the MEMS and amplifying the MEMS signal to a stable and calibrated microphone output voltage.

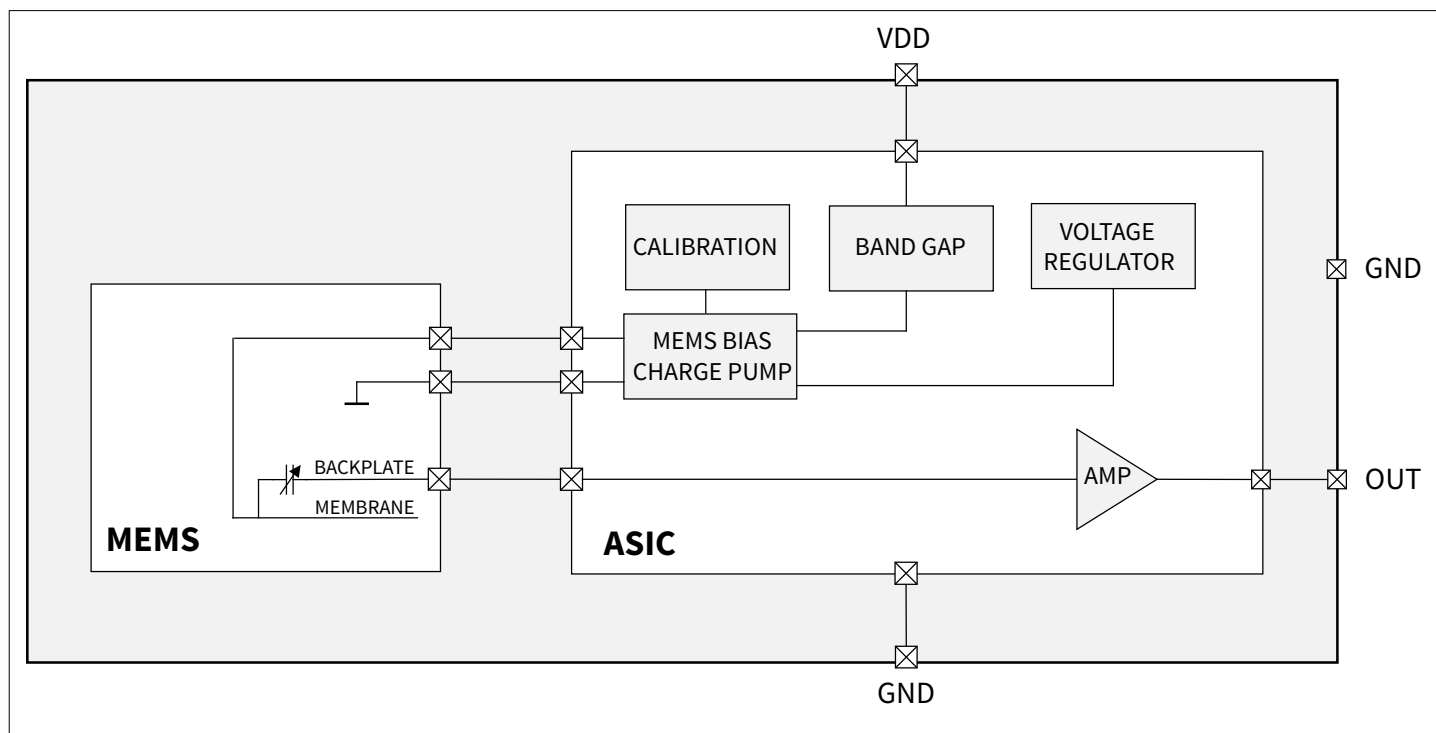


Figure 1 Block diagram

2 Pin configuration

The figure below shows the pin configuration of the device

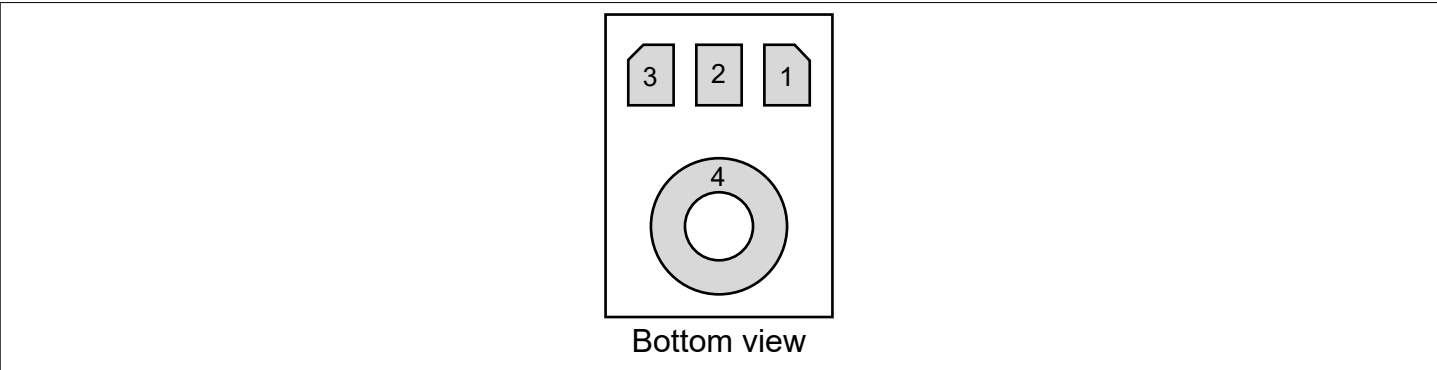


Figure 2

Table 3 Pin configuration

Pin number	Name	Description
1	OUT	Output
2	GND	Ground
3	VDD	Power supply
4	GND	Ground

3 General product characteristics

3.1 Electrical parameters and characteristics

3.1.1 Absolute maximum ratings

Table 4 Absolute maximum ratings

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Storage temperature	T_S	-40	–	125	°C	
Supply voltage	V_{DD}	–	–	4.0	V	
ESD susceptibility human body model (HBM)	$V_{ESD-HBM}$	-2	–	2	kV	all pins according EIA/JESD22/A114

Attention: Stresses above those listed under “Absolute maximum ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the section “Functional range” of this datasheet is not implied. Furthermore, only single error cases are assumed. More than one stress/error case may also damage the device.

Exposure to absolute maximum rating conditions for extended periods may affect device reliability. During absolute maximum rating overload conditions the voltage on VDD pins with respect to ground (GND) must not exceed the values defined by the absolute maximum ratings.

Lifetime statements are an anticipation based on an extrapolation of Infineon’s qualification test results. The actual lifetime of a component depends on its form of application and type of use etc. and may deviate from such statement. Lifetime statements shall in no event extend the agreed warranty period.

3.1.2 Functional range

The following functional range shall not be exceeded in order to ensure correct operation of the device. All parameters specified in the following sections refer to these operating conditions unless otherwise indicated.

Table 5 Functional range

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Supply voltage	V_{DD}	2.4	2.6	3.60	V	A 100nF bypass capacitor should be placed close to the microphone's VDD pin to ensure best SNR performance
Ambient operating temperature	T_A	-40	–	+105	°C	
VDD ramp-up Time	V_{DD_ru}	0.001	–	2	ms	Time until $V_{DD} \geq V_{DD_min}$
Capacitive output load	C_L	–	–	150	pF	DC-coupled
Resistive output load	R_L	10	–	100	kΩ	AC-coupled

4 Product features

4.1 Electrical characteristics

Test conditions (unless otherwise specified in the table): $V_{DD} = 2.6V \pm 0.1V$, $T_A = 25^\circ C \pm 5^\circ C$

Table 6 Electrical characteristics

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Current consumption	I_{DD}	–	105	135	μA	Input ≤ 94 dB SPL, unloaded
Current consumption during startup	$I_{DD_Startup}$	–	–	1	mA	Current peak during startup process
Output DC voltage	V_{OUT_DC}	1.23	1.30	1.37	V	
Output impedance	Z_{out}	–	–	400	Ω	$f = 1$ kHz
Startup time	$t_{startup}$	–	–	10	ms	Time between applying V_{DD_min} till functionality is given
Power supply rejection ratio	PSRR	–	73.5	–	dB	1 kHz sine wave of $200mV_{pp}$ on V_{DD} 1)

1) PSRR is the ratio between a power supply voltage change and the variation of the output signal.

4.2 Acoustic characteristics

The values in the table "Acoustic characteristics" are valid under the following conditions (unless otherwise specified in the table): $V_{DD} = 2.6V \pm 0.1V$, $T_A = 25^\circ C \pm 5^\circ C$, audio bandwidth 20 Hz to 20 kHz, output unloaded

Table 7 Acoustic characteristics

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Sensitivity	Sens	-39	-38	-37	dBV	1 kHz, 94 dB SPL
Signal to noise ratio	SNR	–	64	–	dB(A)	A-Weighted
Equivalent input noise	EIN	–	30	–	dB SPL	A-Weighted
Total harmonic distortion, 94 dB SPL	THD_{94}	–	0.1	–	%	Measuring 2nd to 5th harmonics; 1 kHz
Total harmonic distortion, 1%	$THD_{1\%}$	–	116	–	dB SPL	Measuring 2nd to 5th harmonics; 1 kHz
Acoustic overload point (10% THD)	AOP	–	130	–	dB SPL	Measuring 2nd to 5th harmonics; 1 kHz
Low frequency roll-off point	LFRO	–	10	–	Hz	-3 dB point relative to 1 kHz
Phase response, 75 Hz	Φ_{75}	–	7	–	°	
Phase response, 1 kHz	Φ_{1000}	–	0	–	°	

(table continues...)

Table 7 (continued) Acoustic characteristics

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Phase response, 3kHz	ϕ_{3000}	–	-1	–	°	
Group delay, 250Hz	t_{gd_250}	–	25	–	μs	
Group delay, 600Hz	t_{gd_600}	–	4	–	μs	
Group delay, 1kHz	t_{gd_1000}	–	2	–	μs	
Group delay, 4kHz	t_{gd_4000}	–	0	–	μs	

Polarity: Increasing sound pressure level (SPL) leads to an increasing V_{out} .

Directivity: The device has an omnidirectional pickup pattern.

4.2.1 Free field frequency response

The figure below shows the typical free field response of the device.

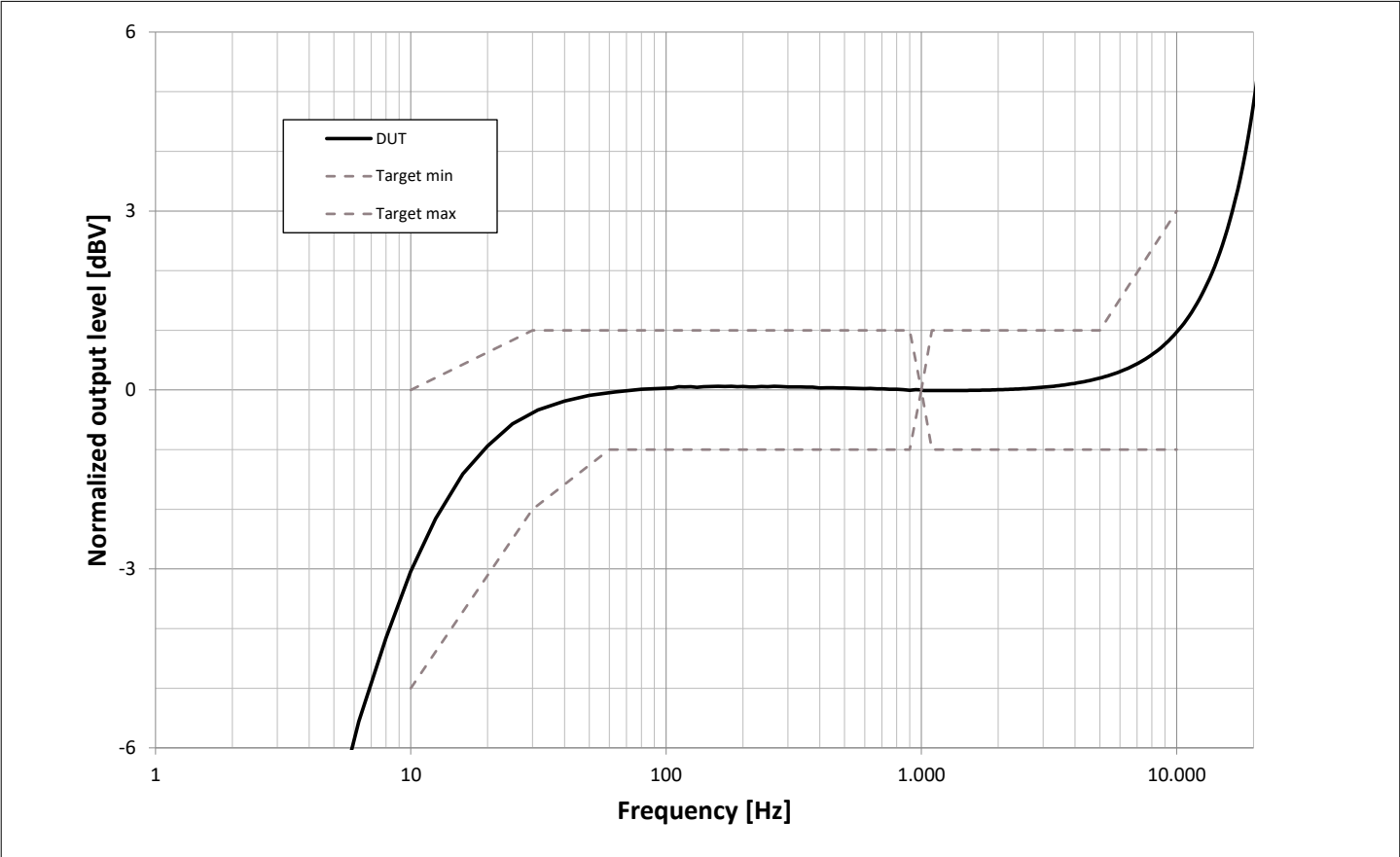


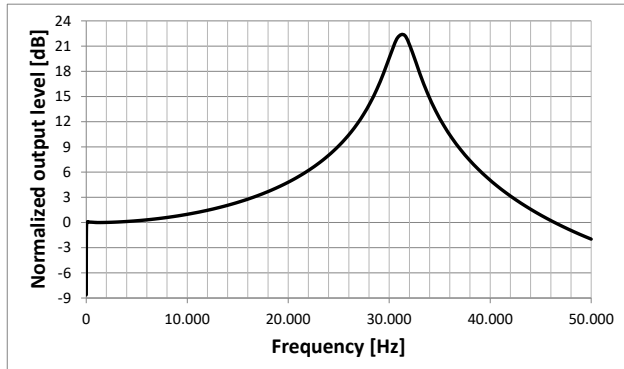
Figure 3 Free field frequency response

Table 8 Free field frequency response, normalized to 1kHz sensitivity value

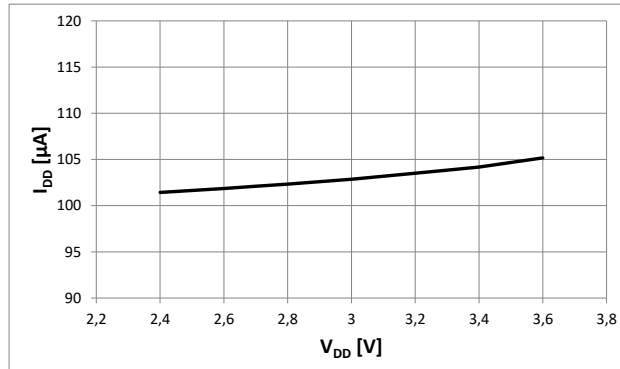
Frequency (Hz)	Lower limit (dB)	Upper limit (dB)
10	-5	0
30	-2	+1
60	-1	+1
100	-1	+1
1000	0	0
5000	-1	+1
10000	-1	+3

4.3 Typical performance characteristics

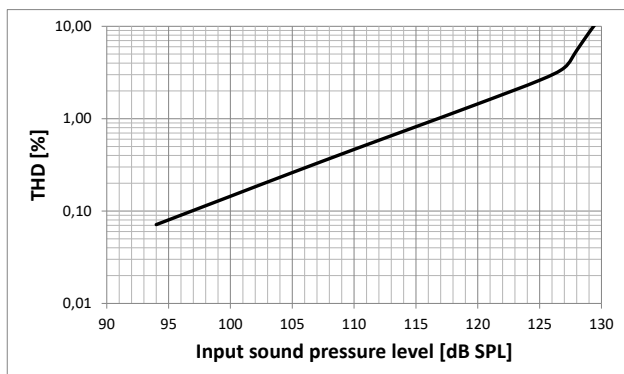
Test conditions: $V_{DD} = 2.6V \pm 0.1V$, $T_A = 25^\circ C \pm 5^\circ C$, output unloaded



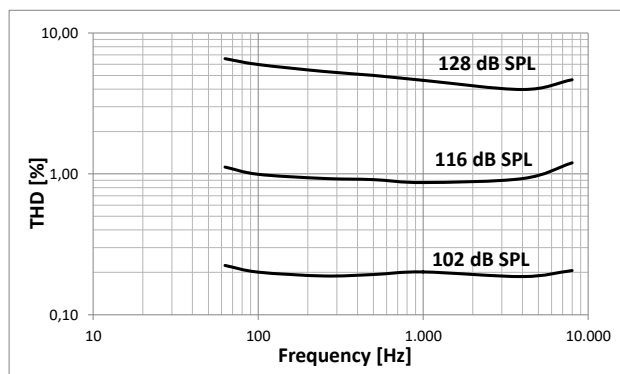
Plot 1: Typical free field response (ultrasonic)



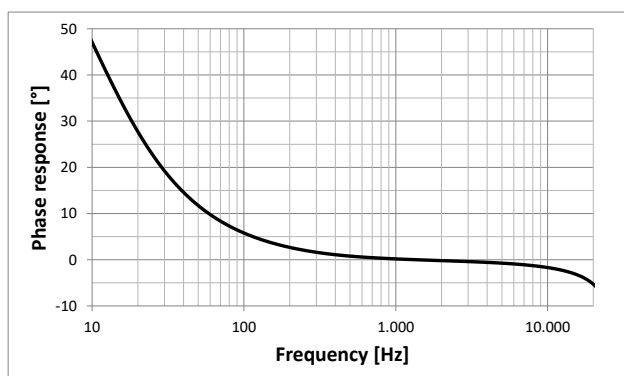
Plot 2: I_{DD} vs. V_{DD}



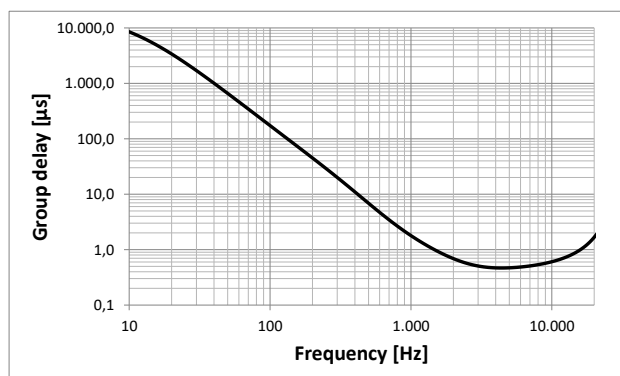
Plot 3: Typical THD vs. SPL @ 1kHz



Plot 4: Typical THD vs. frequency



Plot 5: Typical phase response vs. frequency



Plot 6: Typical group delay vs. frequency

Figure 4 Typical performance characteristics

5 Application information

Note: The following information is given as an example for the implementation of the device only and shall not be regarded as a description or warranty of a certain functionality, condition or quality of the device.

5.1 Use cases

- Flat frequency response with very low LFRO (low frequency roll off point) and small group delay
 - Best performance for active noise cancellation systems (ANC, RNC, ...)
 - Excellent speech quality over full frequency range
- Total harmonic distortion (THD) up to high sound pressure levels (SPL)
 - Clear speech in a wide dynamic range
 - Reliable voice commands even with high background noise
 - Improved ANC system performance in loud environments
- High acoustic overload point (AOP)
 - Distortion less output signal even in loud environments
- High signal to noise ratio (SNR)
 - Far field audio signal pick-up
 - Low volume audio and whispered voice capturing
 - Good performance with speech recognition algorithms
 - Microphone noise is no longer limiting the audio chain
- Close sensitivity and phase matching
 - Good performance in audio beamforming
 - High and precise attenuation of background noise
 - Full utilization of voice algorithms capability

5.2 Typical application circuit

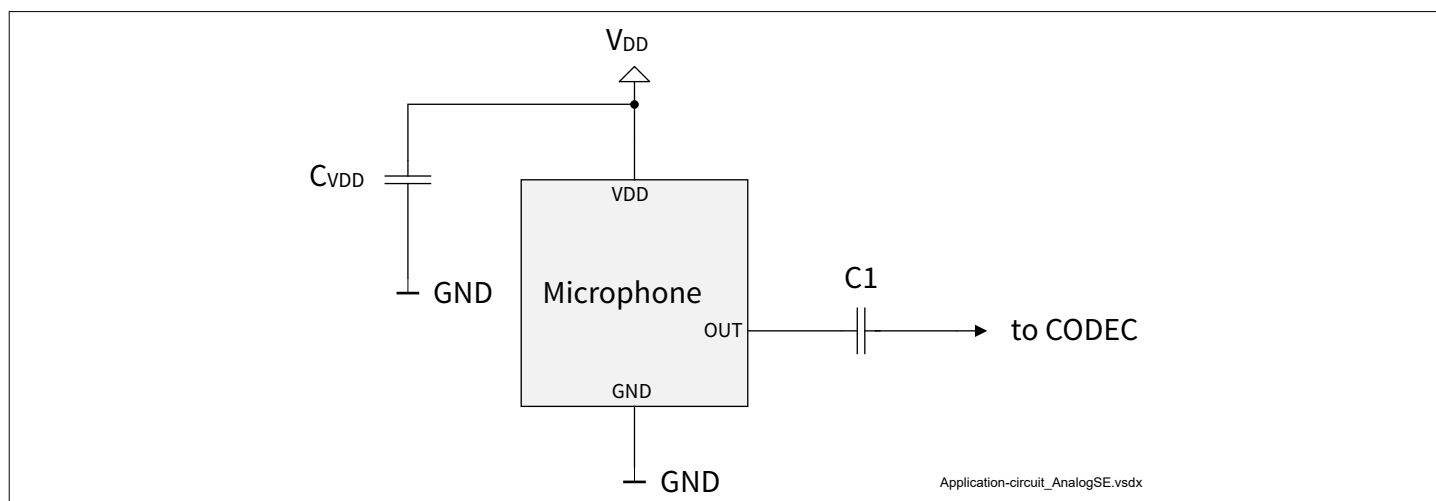


Figure 5 Typical application circuit

Note: For best performance it is strongly recommended to place a 100nF ($C_{VDD_typical}$) capacitor between VDD and ground. The capacitor should be placed as close to VDD as possible.

Note: This figure is a simplified example of an application circuit. The function must be verified in the application.

6 Package information

This product is compliant to RoHS

6.1 Package outline

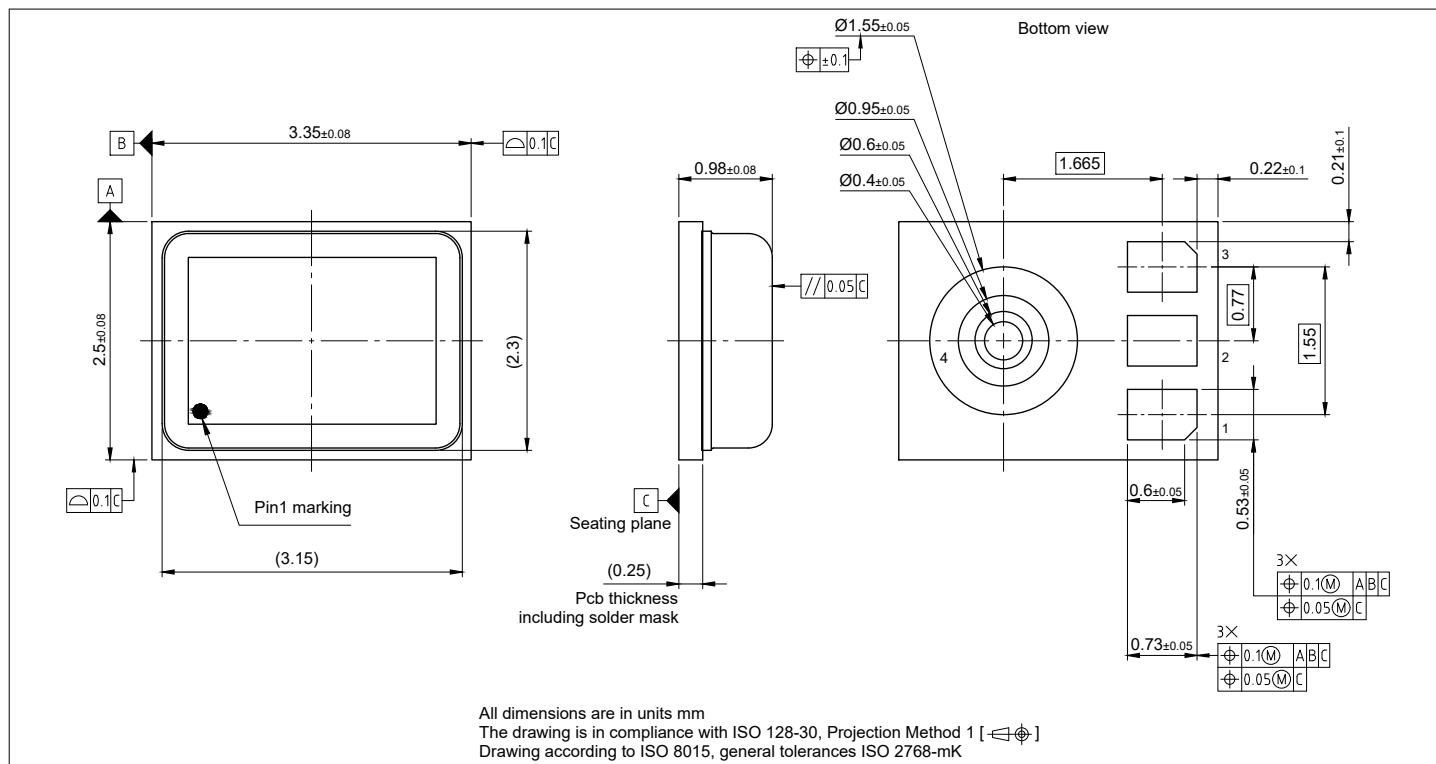


Figure 6 Package outline drawing

6.2 Footprint and stencil recommendation

The acoustic port hole diameter in the PCB should be larger than the acoustic port hole diameter of the MEMS microphone to ensure optimal performance. A PCB sound port size of radius 0.3 mm (diameter 0.6mm) is recommended.

The board pad and stencil aperture recommendations shown in the figure below are based on solder mask defined (SMD) pads. The specific design rules of the board manufacturer should be considered for individual design optimizations or adaptations.

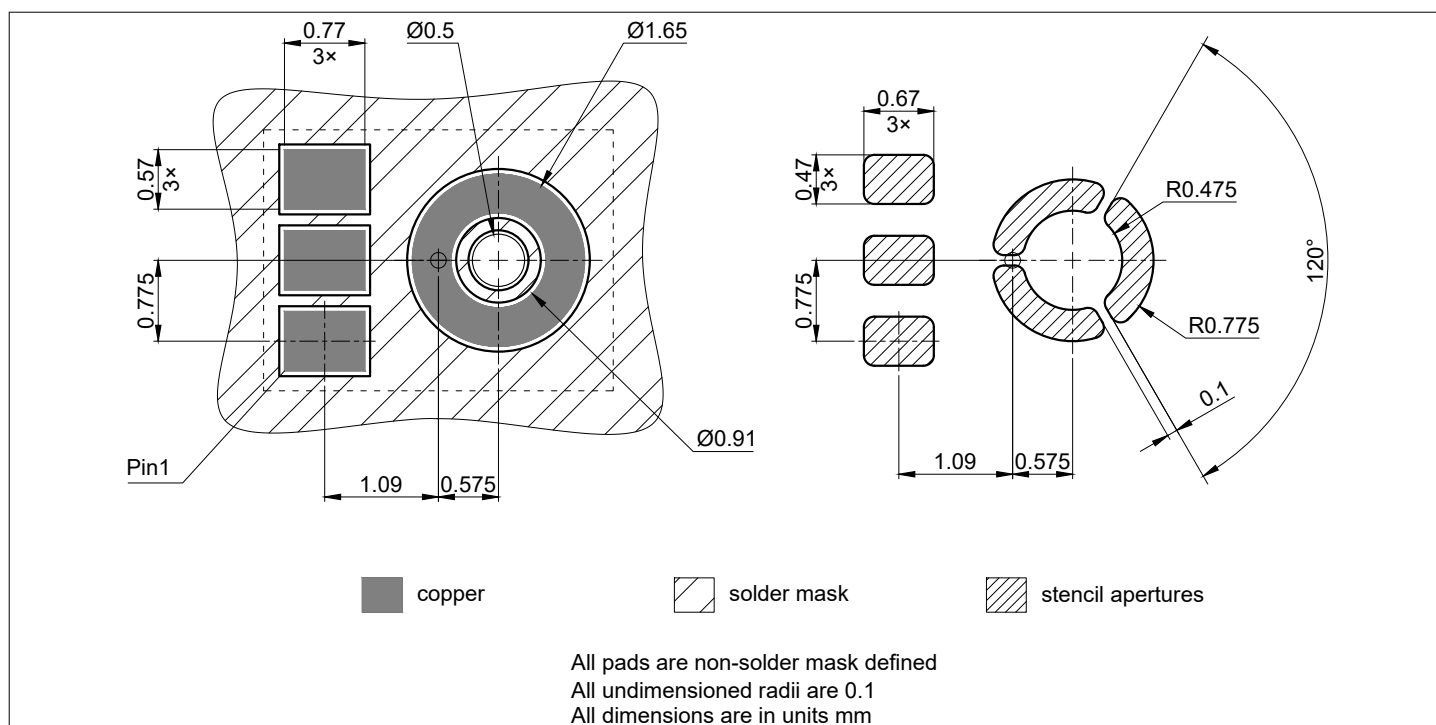


Figure 7 Footprint and stencil recommendation

6.3 Reflow soldering and board assembly

Infineon MEMS microphones are qualified in accordance with the IPC/JEDEC J-STD-020D-01. The moisture sensitivity level of MEMS microphones is rated as MSL1. For PCB assembly of the MEMS microphone the widely used reflow soldering, using a forced convection oven, is recommended.

The soldering profile should be in accordance with the recommendations of the solder paste manufacturer to reach an optimal solder joint quality. The reflow profile shown in the figure below is recommended for board manufacturing with Infineon MEMS microphones.

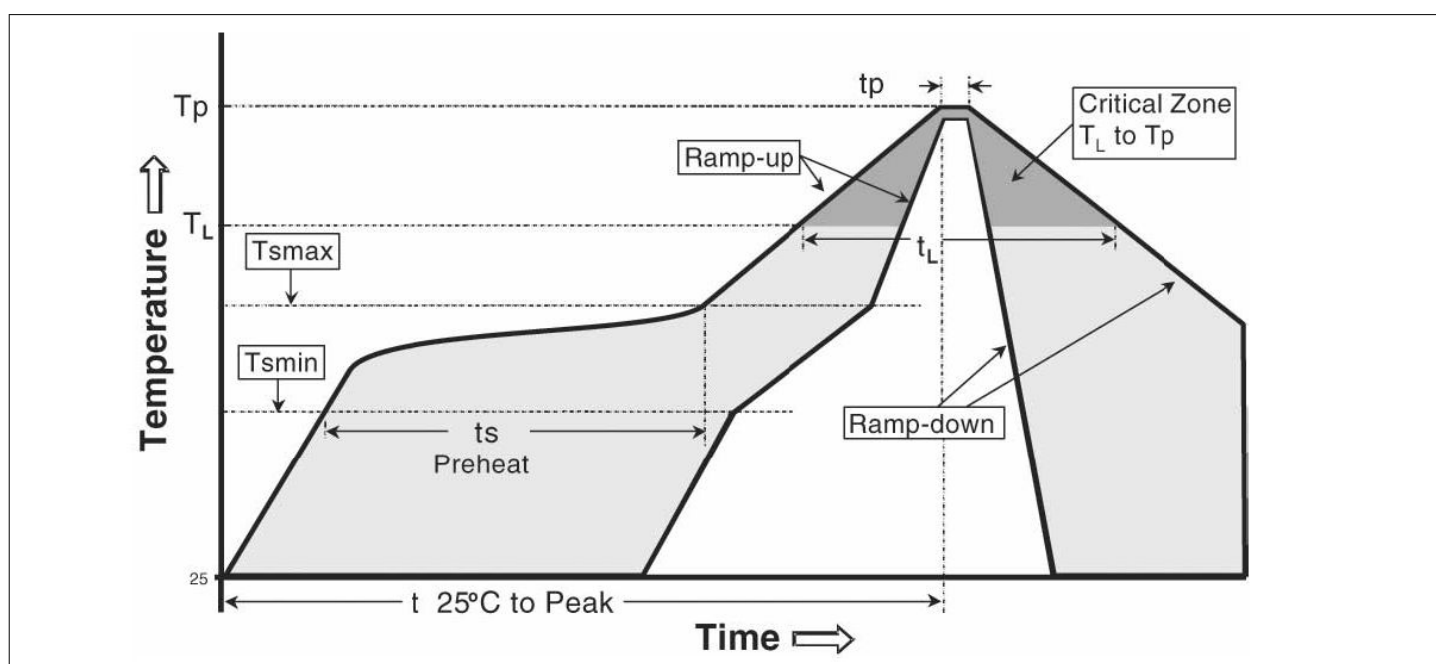


Figure 8 Recommended reflow profile

Table 9 **Reflow profile limits**

Profile feature	Symbol	Pb-free assembly	Sn-Pb Eutectic assembly
Preheat temperature min.	T_{smin}	150°C	100°C
Preheat temperature max.	T_{smax}	200°C	150°C
Preheat time (T_{smin} to T_{smax})	t_s	60-120 seconds	60-120 seconds
Ramp-up rate (T_L to T_P)	–	3°C/second max.	3°C/second max.
Liquidous temperature	T_L	217°C	183°C
Time maintained above T_L	t_L	60-150 seconds	60-150 seconds
Peak temperature	T_P	260°C +0°C/-5°C	235°C +0°C/-5°C
Time within 5°C of actual peak temperature (see note below)	t_P	20-40 seconds	10-30 seconds
Ramp-down rate	–	6°C/second max.	6°C/second max.
Time 25°C to peak temperature	t	8 minutes max.	6 minutes max.

Note: Tolerance for peak profile temperature (T_P) is defined as a supplier minimum and a user maximum.

The MEMS microphones can be handled using industry standard pick and place equipment. Care should be taken to avoid damage to the microphone structure as follows:

- Do not pick the microphone with vacuum tools which make contact with the microphone acoustic port hole.
- The microphone acoustic port hole should not be exposed to vacuum. This can destroy or damage the MEMS.
- Do not blow air into the microphone acoustic port hole. If an air blow cleaning process is used, the port hole must be sealed to prevent particle contamination.
- It is recommended to perform the PCB assembly in a clean room environment in order to avoid microphone contamination.
- Air blow and ultrasonic cleaning procedures shall not be applied to MEMS Microphones. A no-clean paste is recommended for the assembly to avoid subsequent cleaning steps. The microphone MEMS can be severely damaged by cleaning substances.
- To prevent the blocking or partial blocking of the sound port during PCB assembly, it is recommended to cover the sound port with protective tape during PCB sawing or system assembly.
- Do not use excessive force to place the microphone on the PCB. The use of industry standard pick and place tools is recommended in order to limit the mechanical force exerted on the package.

Note: For further information please consult the "General recommendation for assembly of Infineon packages" document, which is available on the Infineon Technologies [web page](#).

6.4 Packing

For shipping and assembly the Infineon microphones are packed in product specific tape-and-reel carriers. A detailed drawing of the carrier can be seen in the figure below.

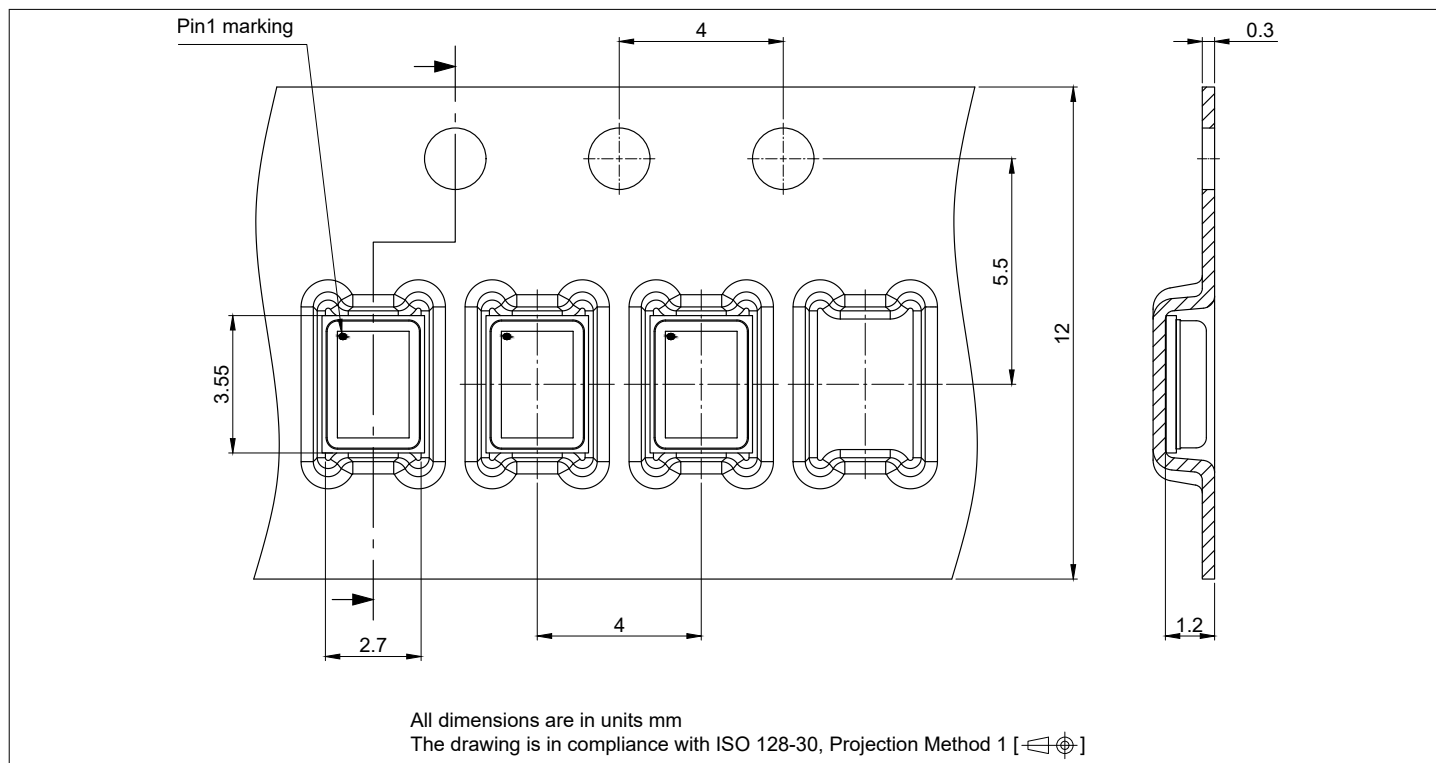


Figure 9 **Tape dimensions**

More information can be found on the Infineon website:

<https://www.infineon.com/cms/en/product/packages/PG-TLGA/PG-TLGA-4-2/>

7 Reliability specifications

The microphone sensitivity after stress and over temperature does not deviate by more than +/- 3dB from the initial value.

Table 10 Qualification tests according to AEC-Q103-003

Test	Stress condition	Standard
Temperature humidity bias (THB)	$T_A = +85^{\circ}\text{C}$, R.H. = 85%, $V_{DD} = 3.6\text{V}$, cyclical bias, 1000 hours	JESD22-A101
Temperature humidity storage (THS)	$T_A = +85^{\circ}\text{C}$, R.H = 85%, 1000 hours	JESD22-A101
Temperature cycling (TC)	$T_A = -55^{\circ}\text{C} \dots +125^{\circ}\text{C}$, 30 min cycle time, 1000cycles	JESD22-A104
High temperature storage life (HTSL)	$T_A = +125^{\circ}\text{C}$, 1000 hours	JESD22-A103
High temperature operating life (HTOL)	$T_A = +125^{\circ}\text{C}$, $V_{DD} = 3.6\text{V}$, 1000 hours	JESD22-A108
Early life failure rate (ELFR)	$T_A = +125^{\circ}\text{C}$, $V_{DD} = 3.6\text{V}$, 48 hours	AEC Q100-008
Mechanical shock (MS)	3 pulses, 0.1ms duration, 10,000g peak acceleration in x,y and z planes	JESD22-B104
Variable frequency vibration (VfV)	20Hz to 2kHz to 20Hz (logarithmic variation) in 4 minutes, 4x in each orientation, 20g peak acceleration	JESD22-B103
Package drop (DROP)	10x on each of 6 axes (60 drops total) from a height of 1.2m onto a concrete surface	AEC Q103-003
Humidity and temperature cycle (HTC)	5 cycles (24h/cycle)	AEC Q103-003 JESD22-A108, IEC 60068-2-38
Low temperature operating life (LTOL)	$T_A = -40^{\circ}\text{C}$, $V_{DD} = 3.6\text{V}$, 1000 hours	JESD22-A108, IEC 60068-2-2, Test-AA
Low temperature storage (LTS)	$T_A = -40^{\circ}\text{C}$, 1000 hours	JESD22-A119, IEC 60068-2-2, Test-AA
Endurance life test (ELT)	96 hours at 130dB continuous signal, Read-out after stress at room temperature	AEC Q103-003
Maximum pressure test (MPT)	160 dBSPL	AEC Q103-003
Electrostatic discharge, Human body model (HBM)	all pins, $V_{ESD} = \pm 2000\text{V}$	AEC Q100-002
Electrostatic discharge, Charged device model (CDM)	all pins, $V_{ESD} = \pm 500\text{V}$	AEC Q100-011
Latch-up	$T_A = 105^{\circ}\text{C}$, $I = \pm 100\text{mA}$	AEC Q100-004
Electromagnetic compatibility (EMC)	IC strip line radiated emissions	SAE J1752/3 – Radiated Emissions

(table continues...)

Table 10 (continued) Qualification tests according to AEC-Q103-003

Test	Stress condition	Standard
Wire bond shear	–	AEC Q100-001, AEC Q003
Wire bond pull	–	MIL-STD883, AEC Q003
Die shear	–	MIL-STD-883
Solderability	–	JESD22-B102
Physical dimensions	–	JESD22-B100 and B108, AEC Q003
Acoustic characterization	Measurement of acoustic parameters over full voltage and temperature range $T_A = -40^{\circ}\text{C} \dots +105^{\circ}\text{C}$ $V_{DD} = 2.4\text{ V} \dots 3.6\text{ V}$	–

Table 11 Additional tests for use in automotive applications

Test	Stress condition	Standard
Electrostatic discharge, SLT - Contact discharge	3 contact discharges of $\pm 6\text{ kV}$ to lid while V_{DD} is supplied according to the operational modes; V_{DD} ground is separated from earth ground	IEC-61000-4-2
Electrostatic discharge, SLT - Air discharge	3 air discharges of $\pm 8\text{ kV}$ to lid while V_{DD} is supplied according to the operational modes; V_{DD} ground is separated from earth ground	IEC-61000-4-2

8 Revision history

Table 12 Revision history

Document revision	Date of release	Description of changes
1.10	2024-04-19	- Extending the operating temperature to 105°C in Table 5 - Editorial Changes
1.00	2024-01-25	Initial release

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